conductors **82** may be umbilical cables. When the pipeline is at an offshore location of greater than about 400 feet, high wire conductors are not preferable, and instead data may be acoustically transmitted from subsurface to the surface buoy.

Referring to FIG. **4**, the monitoring station includes a computer **68** and satellite communications module **86** for interfacing with antenna **22**. Sensors **88**, **88A**, **88B** provide pipeline monitoring signals to input/output module **90**. An analog to digital (A/D) converter **92** may connect module **90** to computer **68**. A digital to analog (D/A) converter **94** provides conversion from the computer to the sensors **88**, with the computer including firmware sufficient to control the various sensors **88**. A command signal from the central monitoring facility **50** to the communications module **86** may be converted by A/D converter **94** for activating actuator **96** which controls opening and closing of valve **98**. The pig position detector **24** and the test leads **70** are preferably used at every monitoring station, and similar A/D converters may be used between the computer **68** and both **24** and **70**.

Data transmission as shown in FIG. **1** is adaptable to a variety of communications systems by selecting a corresponding communications module **86** and antenna **22**. Each communications module **86** may include circuitry to interface the monitoring station **20** to the satellite communications system. The computer **68** is capable of entering a sleep mode to conserve power. The computer **68** may be awake when the magnetic pig **76** as shown in FIG. **2** passes by the monitoring station. The computer alternatively may be awakened in response to a signal from the control station **52** of the central monitoring facility **50**, or in response to a clock within the computer **68**. In either case, the triggering event causes the computer to perform selected tasks.

Although monitoring station **20** could theoretically communicate over a variety of wireless communications channels or mediums, including microwave radio, cellular radio and satellite communications, the preferred choice is the satellite system discussed below. Communication between antenna **22** and central monitoring facility **50** could use a microwave transmission/receiver to communicate with a microwave receiver/transmitter at the central monitoring facility **50**. Links of microwave stations may allow one station to communicate with the next microwave station. Undesirably, however, expensive microwave stations would be required at each monitoring station **20**. Alternatively, a cellular phone network could be developed between a cellular phone links at the monitoring stations to communicate with the central monitoring facility **50**. The use of a truck mounted radio link allows a technician to stay in communication with the pig even though the pig is a great distance removed. Cellular phone transmission often is poor, however, in remote areas where pipeline is often buried.

The preferred wireless communications system between antenna **22** and central monitoring facility **50** is the satellite communication system and service provided by Orbcomm, GlobalStar, or Iridium. Each of these satellite communications systems are Low Earth Orbiting Satellite Systems (LEOs). The satellite of an LEO has an orbital altitude range from 500 to 2000 km above the surface of the Earth. LEO satellites are conventionally part of constellations of satellites that achieve wide coverage of the Earth's surface with lower power requirements and shorter propagation delays that can be achieved with, e.g., geostationary orbit (GEO) satellites. Medium Earth Orbit (MEO) satellites have altitudes from 8000 to 20,000 km above the Earth, and GEOs have altitudes above 35,000 km above the Earth. LEO satellites may have equatorial or polar paths and both data and voice-and-data communications may be transmitted at

preassigned frequency ranges. The LEO satellite system is able to transmit accurate and timely data from pipeline monitoring stations to any location in the world via the Internet.

Transmission from the monitoring station is linked to a satellite **60**, which in turn is linked to Earth station or central monitoring facility **50**, which includes a computer **52**, display screen **54**, and control station **56**. If desired, a fiber optic linkage may be used to transmit data from the satellite receiver **58** to the central monitoring facility **50**, or from the facility **50** to converter **62**, which may then transmit data via the Internet **64** to another database **66**. The approximate delay time between the initial data transmission and receipt of the data at the central monitoring facility should be approximately one minute or less, depending on the site. Those skilled in the art will appreciate that, while the control station **56** as shown in FIG. **1** is part of the central monitoring facility **50**, conventional communication systems may be positioned so that data may be output or displayed at various locations, and control may be from either the central monitoring facility **50** or any of various control stations to the monitoring stations **20** to control activities performed at each monitoring station in response to commands. Also, the monitoring station **20** preferably includes a computer **68**, which at minimum may include a time clock for outputting activity signals to the monitoring station. Also, programs within computer **68** may be programmed by command signals from the central monitoring facility **50** utilizing the satellite communication system **60**.

FIG. **5** is a flow chart of the magnetic sensing module **110** within the computer **68**, or if desired within the computer **52** of the central monitoring facility **50**. The magnetic sensing module **110** may receive eight analog inputs and one or more digital inputs. The analog inputs are converted to digital signals by A/D converter **92** (see FIG. **4**). The computer **68** provides one or more digital outputs and one or more analog outputs that are converted by D/A converter **94**. When power is applied or when the computer is reset, the computer may begin operation by resetting or degaussing the sensor **24**, and performing similar operations on other sensors.

Next, the computer **68** takes readings over a period of time to locate maximum and minimum ambient noise to set data thresholds. The computer **68** then loops between steps to wait for an external event, such as the passage of the magnetic pig. Data is read from the magnetic sensing module **24** and the computer **68** determines if the data indicates passage of the magnetic pig. If the pig has not passed, then the computer **68** again samples data from the magnetic sensing module **24**. If the pig is detected, the computer proceeds to power up the communications module **86** in preparation for data transmission. The computer **68** may also sample data from a field interface unit which includes one or more sensors **88**, then transmits the data to the central monitoring facility **50**. The computer **68** also determines if another field interface unit is connected to the computer and, if so, to sample and transmit the data corresponding to the next field interface module. Once all the data is obtained, the computer **68** proceeds to power down the communications module to conserve power. Even though communications module is powered down, communications receiving circuitry remains powered up to receive data or command form the central monitoring facility **50**. After the data is communicated, the computer **68** proceeds to determine if the magnetic sensor **24** has become saturated. The output of the magnetic pig position detector **24** will drift or become offset if the sensor is again degaussed. If the output from sensor **24** is not saturated, the computer **68** waits for a